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FISC WILLIAMSBURG  
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TECHNICAL MEMORANDUM FINAL CHEATHAM ANNEX SITE 1 GROUNDWATER DATA  
REVIEW AND RISK MANAGEMENT CONSIDERATION FISC WILLIAMSBURG VA  
02/19/2008  
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# Final Cheatham Annex Site 1 Groundwater Data Review and Risk Management Consideration

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DATE: February 19, 2008

This Technical Memorandum (TM) summarizes CERCLA actions and groundwater human health risks at Cheatham Annex (CAX) Site 1, Landfill Near Incinerator. Five removal actions taken at Site 1 have eliminated all unacceptable risk to human health and the environment associated with waste, soil, sediment, and surface water. Mitigation of these risks will be documented in the Construction Completion Reports supporting a no further action Proposed Plan and Record of Decision for these media. A human health risk assessment (HHRA) (Baker, 2004) addendum to the Remedial Investigation (RI) (Baker, 2004a) identified unacceptable risk for potable use of groundwater. This TM presents the rationale for groundwater risk management consideration to support a no action Proposed Plan and Record of Decision for all media at CAX Site 1.

## Background

The Site 1 landfill was used for disposal of incinerator residue from 1942 to 1951, and as a general landfill from 1951 to 1972. Site 1 covers approximately 1.3 acres located along the York River behind a former incinerator that was dismantled between 1989 and 1992. Groundwater data were collected in 2000 and used in a 2004 updated HHRA presented as an addendum to the *Round One Remedial Investigation Report for Site 1 - Landfill Near Incinerator* (Baker 2004, Admin Record # 01475). Five removal actions have been conducted at Site 1 and comprise surface debris removal and river bank stabilization in 2000 (Action A), removal of the main landfill (with the exception of the depression pool area) and shoreline protection in 2003 (Action B), removal of additional landfill material and debris discovered outside the boundaries of the main landfill in 2004 (Action C) and 2005 (Action D), and removal of the remainder of the main landfill (depression pool area) and contaminated sediment within the adjacent wetland area in 2007 (Action E). Post-removal confirmation sampling contained in the construction completion documentation demonstrates the removal of all waste and the mitigation of unacceptable risk associated with soil, sediment, and surface water at Site 1.

## Groundwater Data

Five monitoring wells were sampled in May 2000 at Site 1 as part of the RI; 1-GW05, 1-GW06, 1-GW07, 1-GW09, and 1-GW10. Tables and a figure from the 2004 RI are provided as an attachment to this TM and include; groundwater quality field measurement (Table 4-4), groundwater sample results (Table 5-10), and a groundwater data distribution figure (Figure 5-6). The results for chemicals of concern (COCs) identified in the HHRA Addendum to the 2004 RI (total arsenic, iron, and manganese) are summarized in Table 1 below:

**Table 1: 2004 RI concentrations of total arsenic, iron, and manganese**

Concentrations in µg/L	1-GW05-00	1-GW06-00	1-GW07-00	1-GW09-00	1-GW10-00	1-GW10-00D*
<b>Arsenic</b>	1.98 U	2.1	34.7	2.3	3.5	3.6
<b>Iron</b>	718	578	29,800	497	308	412
<b>Manganese</b>	3.7	1.34 U	505	44.8	111	111

Notes: \* Duplicate sample of 1-GW10-00  
 U – Not detected above associated detection limit

Monitoring wells 1-GW05, 1-GW06, 1-GW09, and 1-GW10 were installed outside the extent of the landfill (see attached Figure 5-6 from RI). The boring log from 1-GW07 identifies that the well screen was located within the extent of the landfill waste and coincides with the highest concentrations for each of the three COCs. Groundwater flow has been calculated to be northeast toward the York River. Monitoring well 1-GW10 was the closest downgradient groundwater sampling location to 1-GW07 at a distance of 75 feet (see attached Figure 5-6 from RI). The concentrations of the COCs in 1-GW10 do not indicate a release of these constituents as they are similar to background concentrations.

Comparisons of site data to the *average of the five site samples* and maximum total background concentrations are summarized in Table 2 below:

**Table 2: Average concentrations of COCs and Comparison with Background**

Results in µg/L	1-GW07	Site 1 Max Without 1-GW07	Site 1 Average With 1-GW07	Site 1 Average Without 1-GW07	Maximum GW Background Conc. For CAX
<b>Arsenic</b>	34.7	3.6	8.9	2.5	12.6
<b>Iron</b>	29,800	718	6,401	551	11,400 J
<b>Manganese</b>	505	111	133	40	760

Note: J – Value is estimated  
 Average concentrations were calculated based on the highest of either 1GW10-00 or 1GW10-00D

The average Site 1 total concentrations for all three compounds in samples from the five wells are below the maximum background concentration for CAX. The landfill waste has been removed and with it, monitoring well 1-GW07, which was screened entirely in the waste itself. It is therefore reasonable to consider groundwater concentrations excluding results of 1-GW07. By doing so, the Site 1 maximum total concentrations (arsenic- 3.6 ug/L ; iron- 718 ug/L; and manganese- 111 ug/L) and average total concentrations (arsenic- 2.5 ug/L ; iron- 551 ug/L; and manganese- 40 ug/L) for all three compounds are well below the maximum background concentrations for CAX.

Comparisons of the *three downgradient site samples* (1GW06, 1GW09, and 1GW10) to upgradient sample (1GW05), the well installed within the waste (1GW07), and base background total concentrations are summarized in Table 3 below.

*Table 3: Groundwater Concentration Comparison*

Results (µg/L)	1-GW07	Max Downgradient Wells Conc.*	Average Downgradient Wells Conc.*	Upgradient Well (1GW05)	Maximum GW Background Conc. For CAX
<b>Arsenic</b>	34.7	3.6	2.7	1.98 U	12.6
<b>Iron</b>	29,800	578	496	718	11,400 J
<b>Manganese</b>	505	111	52.4	3.7	760

**Notes:** \*Downgradient wells consist of 1GW06, 1GW09, and 1GW10.

J – Value is estimated

U – Not detected above associated detection limit

The average and maximum total concentrations of these metals in groundwater samples from downgradient wells for Site 1 are well below maximum background concentrations for CAX. The total concentrations of arsenic, iron and manganese downgradient of Site 1 demonstrate that there is no contaminant migration beyond the boundary of the former landfill.

Furthermore, it should be noted that although not sampled during the Remedial Investigation, an additional well installed within the horizontal limits of the waste was sampled as part of the 1994 Site Investigation (Baker, 1994). The well, 1EW03 (later renamed 1GW03 and since removed) was sampled in August 1992 and analyzed for inorganics. The results of the unfiltered sample detected arsenic at 3.1 J µg/L. This result is consistent with concentrations of arsenic found in the monitoring wells outside the extent of the landfill during the RI investigation. The depth of the well screen was 24.5 to 29.5 feet bgs, which was below the extent of the waste. The results from 1EW03 would further demonstrate that the groundwater risk driven by arsenic detected in samples from monitoring well 1GW07, would be mitigated once the landfill waste was removed.

## Human Health Risk Summary

Using data from all five wells, the only unacceptable risk associated with groundwater was identified from potable use of groundwater by a potential future resident from exposure to arsenic, iron, and manganese based on both Reasonable Maximum Exposure (RME) and central tendency exposure (CTE) concentrations. The RME concentrations were driven by the maximum concentrations from well 1-GW07. The CTE concentrations, which were based on site averages, were also skewed by the concentrations from the sample collected from monitoring well 1-GW07.

The unacceptable risks identified in groundwater from all five wells are (Baker, 2004):

- Child Resident RME cancer risk (2.9E-4) from arsenic
- Child Resident RME non-cancer hazard for arsenic (7.4), iron (6.4), and manganese (1.6)
- Child Resident CTE non-cancer hazard for arsenic (4.9), iron (4.2), and manganese (1.1)

Potential human health risks were re-calculated excluding monitoring well 1-GW07 and although the cumulative non-cancer hazard index is 1.3, there is no unacceptable risk associated with the potable use of groundwater to child resident following the removal of waste based on:

- Individual HQ for the three compounds is less than 1.0 [arsenic (0.77), iron (0.066), and manganese (0.35)].

- Arsenic, iron, and manganese all target different organs so there is no target organ value greater than 1.0.

Table 4 below provides a comparison of future child resident risk assessment for data from all groundwater samples to risk calculated for groundwater data from all wells excluding 1GW07. The tables used to calculate the new risk are provided as attachments to this tech memo (Tables 7.1 and 7.2).

**Table 4 – Future Child Resident Risk Assessment Comparison**

Receptor	Pathway	Chemical of Concern	EPC (µg/L)	RME Cancer Risk	RME Non-Cancer Hazard (HI)	CT Cancer Risk	CT Non-Cancer Hazard (HI)	Cancer Toxicity Factor (CSF) mg/kg-day <sup>-1</sup>	Non-Cancer Toxicity Factor (RfD) mg/kg-day
Future Child Resident With 1GW07	Ingestion	Arsenic	34.7	2.9 x 10 <sup>-4</sup>	7.4	6.4 x 10 <sup>-5</sup>	4.9	1.5	3.0 x 10 <sup>-4</sup>
		Iron	29,800	Non carcinogenic	6.4	Non carcinogenic	4.2	NA	3.0 x 10 <sup>-1</sup>
		Manganese	505	Non carcinogenic	1.6	Non carcinogenic	1.1	NA	2.0 x 10 <sup>-2</sup>
	Dermal	Arsenic	34.7	1.1 x 10 <sup>-6</sup>	2.9 x 10 <sup>-2</sup>	8.3 x 10 <sup>-8</sup>	6.5 x 10 <sup>-3</sup>	1.5	3.0 x 10 <sup>-4</sup>
		Iron	29,800	Non carcinogenic	3.2 x 10 <sup>-2</sup>	Non carcinogenic	7.1 x 10 <sup>-3</sup>	NA	3.0 x 10 <sup>-1</sup>
		Manganese	505	Non carcinogenic	2.1 x 10 <sup>-1</sup>	Non carcinogenic	4.6 x 10 <sup>-2</sup>	NA	8.0 x 10 <sup>-4</sup>
Future Child Resident Without 1GW07	Ingestion	Arsenic	3.6	3.0 x 10 <sup>-5</sup>	0.77	6.6 x 10 <sup>-6</sup>	0.51	1.5	3.0 x 10 <sup>-4</sup>
		Iron	720	Non carcinogenic	0.066	Non carcinogenic	0.044	NA	7.0 x 10 <sup>-1</sup>
		Manganese	110	Non carcinogenic	0.35	Non carcinogenic	0.24	NA	2.0 x 10 <sup>-2</sup>
	Dermal	Arsenic	3.6	2.3 x 10 <sup>-6</sup>	5.1 x 10 <sup>-3</sup>	1.4 x 10 <sup>-8</sup>	1.1 x 10 <sup>-3</sup>	1.5	3.0 x 10 <sup>-4</sup>
		Iron	720	Non carcinogenic	4.3 x 10 <sup>-4</sup>	Non carcinogenic	9.5 x 10 <sup>-5</sup>	NA	7.0 x 10 <sup>-1</sup>
		Manganese	110	Non carcinogenic	5.9 x 10 <sup>-2</sup>	Non carcinogenic	1.3 x 10 <sup>-2</sup>	NA	8.0 x 10 <sup>-4</sup>

## Groundwater Risk Management Considerations

Potential potable groundwater-use risks identified in the RI for CAX Site 1 warrant risk management consideration based on the following:

- The source for potential groundwater contamination (all waste and impacted soil) has been removed from the site.
- The maximum and mean concentrations of arsenic, iron, and manganese in groundwater samples from all wells immediately downgradient, side-gradient, and upgradient of the former landfill are below background levels and at concentrations that do not pose unacceptable potable groundwater-use risk.
- All potentially unacceptable risks associated with the potable use of groundwater were driven by groundwater data collected from one well (1-GW07) screened entirely within the waste, which has been removed.

## References

Baker, 1994. *Final Site Investigation for Sites 1, 10, and 11*. Naval Supply Center, Cheatham Annex. Williamsburg, Virginia. November 1994.

Baker. 2004. *Final Round I Remedial Investigation Report. Site 1 – Landfill Near Incinerator*. Naval Weapons Station Yorktown, Yorktown, Virginia, Cheatham Annex Site. February 2004.

Baker 2004a. *Addendum to the Human Health Risk Assessment for the Final Round I Remedial Investigating Report Site 1 – Landfill Near Incinerator*; Naval Weapons Station Yorktown, Cheatham Annex, February 2004

Bhate Environmental Associates, Inc. (Bhate). 2004. *Draft Project Closeout Report. Site 1- Landfill Near Incinerator and Site 7N- Old DuPont Disposal Area*. Naval Weapons Station Yorktown, Cheatham Annex.

USEPA. 2007. Integrated Risk Information System Database.

Attachments: Site Figure

Historical Data

Revised Risk Assessment

# Groundwater Risk Management Consensus

The Navy, in partnership with the USEPA and VDEQ, determined potential groundwater risks at CAX Site 1 to be acceptable for unrestricted use/unrestricted exposure (UU/UE).

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NAVFAC Mid-Atlantic

 \_\_\_\_\_ Date 4/21/08

Mr. Rob Thomson;  
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Virginia DEQ

 \_\_\_\_\_ Date 4/24/08

# **Attachments**

Historical Data

Site Figures

Revised Risk Assessment

2004 Remedial Investigation  
Groundwater Quality Data  
Analytical Data  
Figures

TABLE 4-4

**SUMMARY OF PURGE WATER QUALITY PARAMETERS  
REMEDIAL INVESTIGATION FOR SITE 1 - LANDFILL NEAR INCINERATOR  
NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA  
CHEATHAM ANNEX SITE**

Well ID Date Sampled Avg. Flow Rate	Time	Well Volume	Purge Volume (gal.)	Water Quality Parameters				
				Specific Conductivity (mS/cm)	Temperature (°C)	pH (SU)	Turbidity (NTU)	Dissolved Oxygen (mg/L)
1-GW05 May 15, 2000 0.57 L/min	1651	1	1.4	0.438	17.4	7.37	33	5.43
	1701	2	2.8	0.429	16.4	7.07	20	5.7
	1711	3	4.4	0.429	15.7	7.01	10	5.58
1-GW06 May 15, 2000 0.27 L/min	1205	1	1.25	0.782	20.6	6.98	37	6.66
	1222	2	2.5	0.76	18.3	6.69	36	4.54
	1237	3	3.75	0.771	18.4	6.96	34	3.05
	1300	4	5	0.765	18.8	7.01	17	3.96
	1315	5	6.25	0.759	19	6.94	17	3.9
1-GW07 May 15, 2000 0.77 L/min	1802	1	4.4	1.26	17.1	6.64	3	1.38
	1813	1.5	6.6	1.35	16.5	6.65	2	1.24
	1822	2	8.8	1.41	16.4	6.75	1	1.23
	1834	2.5	11	1.43	16.6	6.77	0	1.16
	1845	3	13.2	1.42	16.2	6.76	0	1.08
1-GW09 May 15, 2000 0.42 L/min	0958	1	1.8	1.07	17.1	6.7	14	6.8
	1015	2	3.6	0.99	16.6	6.65	13	3.4
	1031	3	5.4	0.96	17.1	6.81	13	3.5
	1047	4	7.2	0.94	17.3	6.75	11	1.82
1-GW10 May 15, 2000 0.48 L/min	1255	1	2.2	0.675	18.5	7.7	10	3.03
	1315	2	4.4	0.672	17.5	7.51	7	2.75
	1330	3	6.6	0.681	17.3	7.39	4	2.51

Notes:

SU = Standard Units

NTU = Nephelometric Turbidity Units

mS = Microsiemens

TABLE 5-10

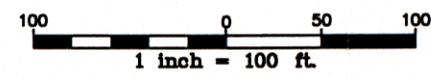
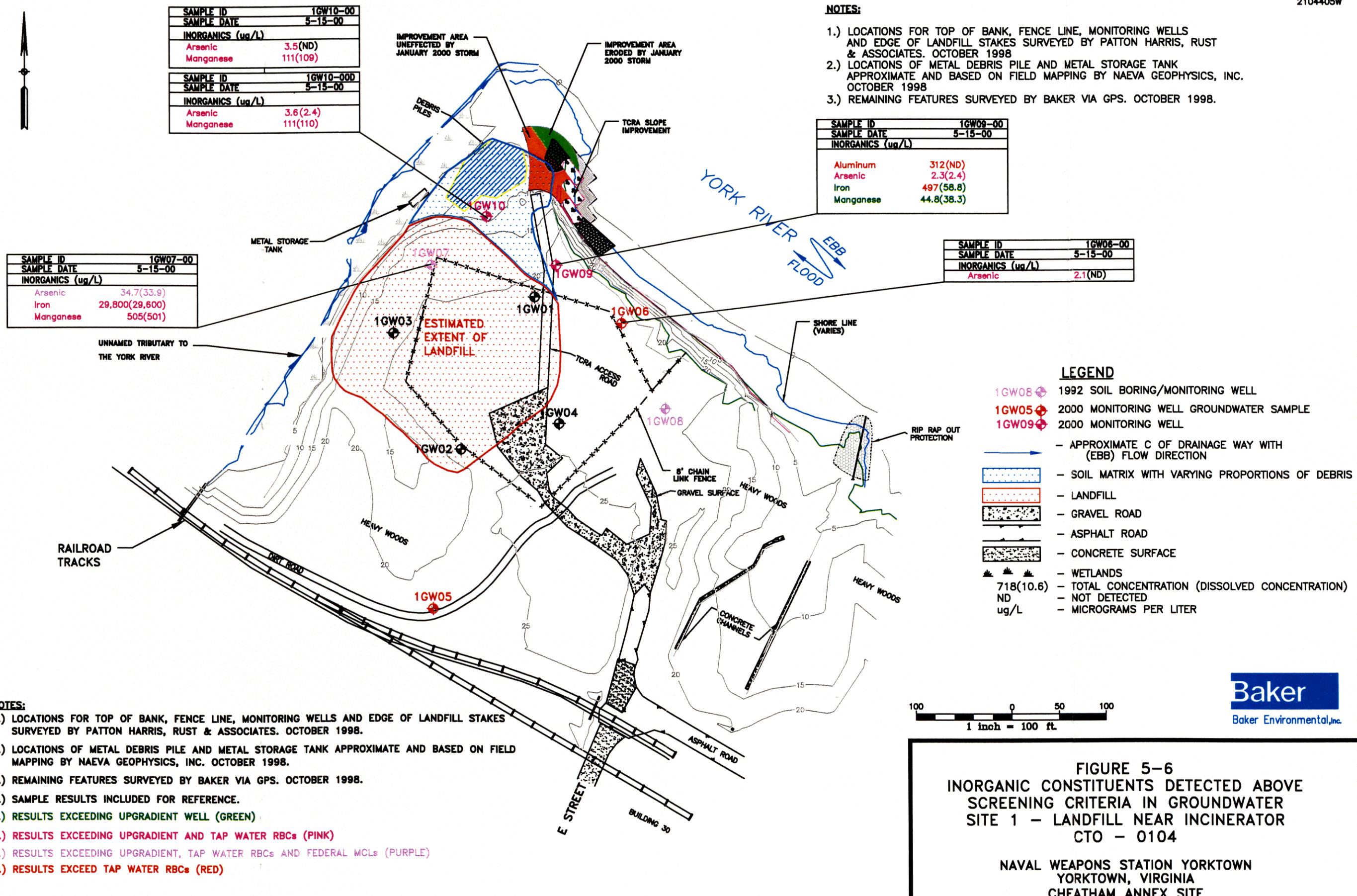
**GROUNDWATER - INORGANIC COMPOUNDS  
SITE 1 - LANDFILL NEAR INCINERATOR  
REMEDIAL INVESTIGATION REPORT  
NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA  
CHEATHAM ANNEX SITE**

Sample_ID	1-GW05-00	1-GW06-00	1-GW07-00	1-GW09-00	1-GW10-00	1-GW10-00D
Date Sampled	05/15/00	05/15/00	05/15/00	05/15/00	05/15/00	05/15/00
<b>Dissolved Inorganics (ug/L)</b>						
Aluminum	16.44 U					
Antimony	2.32 U					
Arsenic	1.98 U	1.98 U	33.9	2.3	1.98 U	2.4
Barium	12.4	57.8	210	61.2	32.9	32.8
Beryllium	0.56 U					
Cadmium	2.61 U	2.61 U	2.8	2.61 U	2.61 U	2.61 U
Calcium	83300	163000	232000	194000	137000	136000
Chromium	1.6	4.02 U	4.02 U	0.74 U	0.74 U	0.74 U
Cobalt	2.98 U	3	2.98 U	2.98 U	2.98 U	3
Copper	1.93 U					
Cyanide						
Iron	10.6	15.3	29600	14.2	49.3	58.8
Lead	1.48 U					
Magnesium	1780	7090	44800	11400	3120	3100
Manganese	1.34 U	1.34 U	501	38.3	109	110
Mercury	0.03	0.04	0.04	0.03	0.05	0.02
Nickel	11.9 U					
Potassium	3080	5470	32900	5620	1780	2000
Selenium	2.98 U					
Silver	2.74 U					
Sodium	5510	6060	26000	13700	9680	9780
Thallium	3.28 U					
Vanadium	4.01 U	4.01 U	4.4	4.01 U	4.01 U	4.01 U
Zinc	3.4	5.1	122	2.8	5.8	4

TABLE 5-10 (Continued)

**GROUNDWATER - INORGANIC COMPOUNDS  
SITE 1 - LANDFILL NEAR INCINERATOR  
REMEDIAL INVESTIGATION REPORT  
NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA  
CHEATHAM ANNEX SITE**

Sample_ID Date Sampled	1-GW05-00 05/15/00	1-GW06-00 05/15/00	1-GW07-00 05/15/00	1-GW09-00 05/15/00	1-GW10-00 05/15/00	1-GW10-00D 05/15/00
<b>Total Inorganics (ug/L)</b>						
Aluminum	479	326	62.4	312	176	311
Antimony	2.32 U					
Arsenic	1.98 U	2.1	34.7	2.3	3.5	3.6
Barium	12.8	54.6	214	63	33.2	33.7
Beryllium	0.56 U					
Cadmium	2.61 U					
Calcium	84500	154000	234000	200000	138000	138000
Chromium	4.02 U	7.6	4.02 U	7.7	4.02 U	4.02 U
Cobalt	2.98 U	2.98 U	2.98 U	2.98 U	3	2.98 U
Copper	1.93 U					
Cyanide	10 U					
Iron	718	578	29800	497	308	412
Lead	1.48 U					
Magnesium	1840	6610	44900	11600	3200	3200
Manganese	3.7	1.34 U	505	44.8	111	111
Mercury	0.02 U	0.02	0.03	0.04	0.03	0.04
Nickel	11.9 U					
Potassium	3320	4500	33100	5860	1950	1980
Selenium	2.98 U					
Silver	2.74 U					
Sodium	5510	5560	26000	14000	9930	10100
Thallium	3.28 U					
Vanadium	4.4	4.4	4.01 U	4.01 U	4.4	4.4
Zinc	8.3	4.8	127	5.6	6.2	6.5



**FIGURE 5-6**  
**INORGANIC CONSTITUENTS DETECTED ABOVE**  
**SCREENING CRITERIA IN GROUNDWATER**  
**SITE 1 - LANDFILL NEAR INCINERATOR**  
**CTO - 0104**

NAVAL WEAPONS STATION YORKTOWN  
 YORKTOWN, VIRGINIA  
 CHEATHAM ANNEX SITE

# Revised Risk Assessment

TABLE 7.1.RME  
 CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
 REASONABLE MAXIMUM EXPOSURE  
 Site 1 - Cheathan Annex Site, Naval Weapons Station Yorktown, Yorktown, Virginia

Scenario Timeframe: Future  
 Receptor Population: Resident  
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Shallow Aquifer - Tap Water	Ingestion	Arsenic	3.6E+00	µg/L	3.4E-05	mg/kg/day	1.5E+00	1/(mg/kg-day)	5.1E-05	9.9E-05	mg/kg/day	3.0E-04	mg/kg/day	3.3E-01
				Iron	7.2E+02	µg/L	6.7E-03	mg/kg/day	NA	NA	NA	2.0E-02	mg/kg/day	7.0E-01	mg/kg/day	2.8E-02
				Manganese	1.1E+02	µg/L	1.0E-03	mg/kg/day	NA	NA	NA	3.0E-03	mg/kg/day	2.0E-02	mg/kg/day	1.5E-01
			Exp. Route Total								5.1E-05					5.1E-01
			Dermal	Arsenic	3.6E+00	µg/L	1.8E-07	mg/kg/day	1.5E+00	1/(mg/kg-day)	2.6E-07	5.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Iron	7.2E+02	µg/L	3.5E-05	mg/kg/day	NA	NA	NA	1.0E-04	mg/kg/day	7.0E-01	mg/kg/day	1.5E-04
				Manganese	1.1E+02	µg/L	5.4E-06	mg/kg/day	NA	NA	NA	1.6E-05	mg/kg/day	8.0E-04	mg/kg/day	2.0E-02
			Exp. Route Total								2.6E-07					2.2E-02
			Exposure Point Total								5.1E-05					5.3E-01
			Exposure Medium Total								5.1E-05					5.3E-01
Groundwater Total								5.1E-05					5.3E-01			
Total of Receptor Risks Across All Media										5.1E-05	Total of Receptor Hazards Across All Media				5.3E-01	

Notes:  
 NA = Not applicable  
 DAevent for exposure to groundwater while showering calculated on Table 7.1.RME Supplement A.

TABLE 7.2.RME  
 CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
 REASONABLE MAXIMUM EXPOSURE  
 Site 1 - Cheathan Annex Site, Naval Weapons Station Yorktown, Yorktown, Virginia

Scenario Timeframe: Future  
 Receptor Population: Resident  
 Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Shallow Aquifer - Tap Water	Ingestion	Arsenic	3.6E+00	µg/L	2.0E-05	mg/kg/day	1.5E+00	1/(mg/kg-day)	3.0E-05	2.3E-04	mg/kg/day	3.0E-04	mg/kg/day	7.7E-01	
				Iron	7.2E+02	µg/L	4.6E-02	mg/kg/day	NA	NA	NA	4.6E-02	mg/kg/day	7.0E-01	mg/kg/day	6.6E-02	
				Manganese	1.1E+02	µg/L	7.1E-03	mg/kg/day	NA	NA	NA	7.1E-03	mg/kg/day	2.0E-02	mg/kg/day	3.5E-01	
				Exp. Route Total							3.0E-05						1.2E+00
			Dermal	Arsenic	3.6E+00	µg/L	1.5E-06	mg/kg/day	1.5E+00	1/(mg/kg-day)	2.3E-06	1.5E-06	mg/kg/day	3.0E-04	mg/kg/day	5.1E-03	
				Iron	7.2E+02	µg/L	3.0E-04	mg/kg/day	NA	NA	NA	3.0E-04	mg/kg/day	7.0E-01	mg/kg/day	4.3E-04	
				Manganese	1.1E+02	µg/L	4.7E-05	mg/kg/day	NA	NA	NA	4.7E-05	mg/kg/day	8.0E-04	mg/kg/day	5.9E-02	
				Exp. Route Total							2.3E-06						6.4E-02
				Exposure Point Total							3.2E-05						1.3E+00
				Exposure Medium Total							3.2E-05						1.3E+00
	Groundwater Total							3.2E-05						1.3E+00			
									Total of Receptor Risks Across All Media	3.2E-05	Total of Receptor Hazards Across All Media				1.3E+00		

Notes:  
 NA = Not applicable  
 DAevent for exposure to groundwater while showering calculated on Table 7.2.RME Supplement A.

TABLE 7.1.CTE  
 CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
 CENTRAL TENDENCY EXPOSURE

Site 1 - Cheathan Annex Site, Naval Weapons Station Yorktown, Yorktown, Virginia

Scenario Timeframe: Future  
 Receptor Population: Resident  
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Shallow Aquifer - Tap Water	Ingestion	Arsenic	3.6E+00	µg/L	4.6E-06	mg/kg/day	1.5E+00	1/(mg/kg-day)	6.9E-06	4.6E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01	
				Iron	7.2E+02	µg/L	9.2E-04	mg/kg/day	NA	NA	NA	9.2E-03	mg/kg/day	7.0E-01	mg/kg/day	1.3E-02	
				Manganese	1.1E+02	µg/L	1.4E-04	mg/kg/day	NA	NA	NA	1.4E-03	mg/kg/day	2.0E-02	mg/kg/day	7.1E-02	
				<b>Exp. Route Total</b>							6.9E-06					2.4E-01	
				Dermal	Arsenic	3.6E+00	µg/L	1.5E-08	mg/kg/day	1.5E+00	1/(mg/kg-day)	2.2E-08	1.5E-07	mg/kg/day	3.0E-04	mg/kg/day	4.9E-04
					Iron	7.2E+02	µg/L	3.0E-06	mg/kg/day	NA	NA	NA	3.0E-05	mg/kg/day	7.0E-01	mg/kg/day	4.2E-05
			Manganese		1.1E+02	µg/L	4.6E-07	mg/kg/day	NA	NA	NA	4.6E-06	mg/kg/day	8.0E-04	mg/kg/day	5.7E-03	
			<b>Exp. Route Total</b>							2.2E-08					6.3E-03		
			<b>Exposure Point Total</b>							6.9E-06					2.4E-01		
			<b>Exposure Medium Total</b>							6.9E-06					2.4E-01		
<b>Groundwater Total</b>							6.9E-06					2.4E-01					
<b>Total of Receptor Risks Across All Media</b>										6.9E-06	<b>Total of Receptor Hazards Across All Media</b>					2.4E-01	

Notes:  
 NA = Not applicable  
 DAdvent for exposure to groundwater while showering calculated on Table 7.1.CTE Supplement A.

TABLE 7.2.CTE  
 CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
 CENTRAL TENDENCY EXPOSURE  
 Site 1 - Cheathan Annex Site, Naval Weapons Station Yorktown, Yorktown, Virginia

Scenario Timeframe: Future  
 Receptor Population: Resident  
 Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Shallow Aquifer - Tap Water	Ingestion	Arsenic	3.6E+00	µg/L	4.4E-06	mg/kg/day	1.5E+00	1/(mg/kg-day)	6.6E-06	1.5E-04	mg/kg/day	3.0E-04	mg/kg/day	5.1E-01	
				Iron	7.2E+02	µg/L	8.8E-04	mg/kg/day	NA	NA	NA	3.1E-02	mg/kg/day	7.0E-01	mg/kg/day	4.4E-02	
				Manganese	1.1E+02	µg/L	1.4E-04	mg/kg/day	NA	NA	NA	4.7E-03	mg/kg/day	2.0E-02	mg/kg/day	2.4E-01	
				<b>Exp. Route Total</b>							6.6E-06					7.9E-01	
				Dermal	Arsenic	3.6E+00	µg/L	9.6E-09	mg/kg/day	1.5E+00	1/(mg/kg-day)	1.4E-08	3.4E-07	mg/kg/day	3.0E-04	mg/kg/day	1.1E-03
					Iron	7.2E+02	µg/L	1.9E-06	mg/kg/day	NA	NA	NA	6.7E-05	mg/kg/day	7.0E-01	mg/kg/day	9.5E-05
			Manganese		1.1E+02	µg/L	3.0E-07	mg/kg/day	NA	NA	NA	1.0E-05	mg/kg/day	8.0E-04	mg/kg/day	1.3E-02	
			<b>Exp. Route Total</b>							1.4E-08					1.4E-02		
			<b>Exposure Point Total</b>							6.6E-06						8.1E-01	
			<b>Exposure Medium Total</b>							6.6E-06						8.1E-01	
<b>Groundwater Total</b>							6.6E-06						8.1E-01				
<b>Total of Receptor Risks Across All Media</b>										6.6E-06	<b>Total of Receptor Hazards Across All Media</b>					8.1E-01	

Notes:  
 NA = Not applicable  
 DAdvent for exposure to groundwater while showering calculated on Table 7.2.CTE Supplement A.